

CHAPTER 1

INTRODUCTION

1-1. Purpose

The purpose of this manual is to present an integrated set of design and installation requirements for grounding and bonding practices in new and existing Command, Control, Communications, Computer, Intelligence, Surveillance, and Reconnaissance (C4ISR) facilities. Grounding and bonding alone will not and cannot guarantee absolute protection against electromagnetic (EM) environmental threats. Improper grounding and bonding practices, however, can negate the effectiveness of other protective measures, such as EM protection, TEMPEST protection, shielding, and surge suppression.

a. EM protection. EM protection requirements are intended to limit the spurious emissions given off by electronic equipment and to ensure that electronic equipment is not adversely affected by such emissions. Typical EM requirements are contained in CFR 47 or in documents promulgated by Technical Committee 77 (Electromagnetic Compatibility) of the International Electrotechnical Commission (IEC).

b. TEMPEST protection. Transient electromagnetic pulse emanation standard (TEMPEST) protection is a government standard with the purpose of protecting the compromising emanations from any information processing equipment from the possibility of interception and extraction of classified information by unauthorized parties.

c. EM and TEMPEST grounding and bonding practices. A Faraday cage that provides an electromagnetic and radio frequency shield enveloping the electronic equipment to be protected best describes the basic requirements of EM and TEMPEST protection. This shield isolates the protected circuits from spurious external signals and also attenuates TEMPEST emanations to levels that are too small to be intercepted or analyzed. To be usable this shield must have penetrations for personnel and equipment access, power lines, control cables, and ventilation. The number of shield penetrations must be held to a minimum since each penetration is a potential leakage source unless properly grounded and bonded. Shielding hardware and a power distribution system designed to meet the objectives of EM and TEMPEST protection guidelines must always meet the requirements of the *National Electrical Code®*, NFPA 70-1999 (*NEC®*). In particular, the grounding and bonding of shields and associated components must comply with Article 250 of the *NEC®*. (*National Electrical Code®* and *NEC®* are registered trademarks of the National Fire Protection Association Inc., Quincy, MA 02269.)

d. Recommended grounding and bonding practices. The recommended grounding and bonding practices are designed to: (1) accomplish adequate fault and lightning protection, (2) allow effective TEMPEST protection to be implemented, (3) support reliable signal and data transmission without introducing noise coupling via safety grounds, and (4) maintain the integrity of electromagnetic interference (EMI) control and electromagnetic pulse (EMP) hardness measures. C4ISR facilities and the interconnections between the various system elements are very complex. Existing documentation of the as-installed grounding and bonding networks is typically not kept current. Therefore, this manual will provide a unified set of grounding and bonding practices specifically formulated for standard C4ISR facilities.

1-2. Scope

The scope of this manual is to provide general guidance for design, construction, modification, inspection, and acceptance testing of the grounding and bonding subsystems for building protection, electrical power ground fault protection, lightning protection, and signal ground protection for both new and existing C4ISR facilities. The procedures presented in this manual are basic. Detailed information and specific instructions for each particular project should be observed.

1-3. Objectives

The objective to this manual is to define the state of the art and most commonly accepted practices for an integrated set of grounding and bonding practices for design and installation that is applicable to both new and existing C4ISR facilities.

1-4. References

Appendix A contains a complete listing of references used in this manual. Prescribed forms are also listed in appendix A, page A-4.

1-5. Overview of the inspection program

The inspection program is divided into two groups of forms. The first group contains Department of the Army (DA) forms for guidance to the electrical inspector in the inspection of new C4ISR facilities and is found in chapter 3. The second group pertains to existing C4ISR facilities and is found in chapter 6.

a. New facilities. Figure 3-5 illustrates how the information for DA Form 7452-R (Earth Ground Electrode Subsystem Checklist for New Facilities) is recorded by electrical inspectors checking the earth ground electrode subsystem. Figure 3-12 illustrates a sample of DA Form 7452-1-R (Ground Fault Protection Subsystem Checklist for New Facilities) as does figure 3-31 for DA Form 7452-1-R (Lightning Protection Grounding Subsystem Checklist for New facilities) and figure 3-38 for DA Form 7452-2-R (Signal Ground Reference Subsystem Checklist for New Facilities). These four may be found at the end of the manual as reproducible forms.

b. Existing facilities. Typically, existing C4ISR facilities have been built to a variety of building codes that either directly dictated specific grounding and bonding practices or indirectly restricted what could be done. Consequently, the practices may vary or be incomplete with respect to other environmental grounding and bonding practices. Major modifications to the grounding system may need to be done in phases or may need to wait until a major equipment upgrade is being performed so that the new grounding measures can be implemented as a part of the equipment changeover. Figure 6-1 illustrates a sample filled-out form for use by electrical inspectors in completing the DA Form 7452-4-R (Earth Electrode Subsystem Checklist for Existing Facilities). Figure 6-2 illustrates a sample of DA Form 7452-5-R (Grounding and Bonding Connection Checklist for Existing Facilities) as does figure 6-3 for DA Form 7452-6-R (Lightning Protection Grounding Subsystem Checklist for Existing Facilities) and figure 6-4 for DA Form 7452-7-R (Ground Fault Protection Subsystem Checklist for Existing Facilities). Figure 6-5 illustrates a sample DA Form 7452-8-R (Signal Ground Reference Subsystem Checklist for Existing Facilities) and figure 6-6 is an illustration for DA Form 7452-9-R (Shielding Subsystem Checklist for Existing Facilities). These six may be found at the end of the manual as reproducible forms.